Army Ground Robotics for Future Combat Systems

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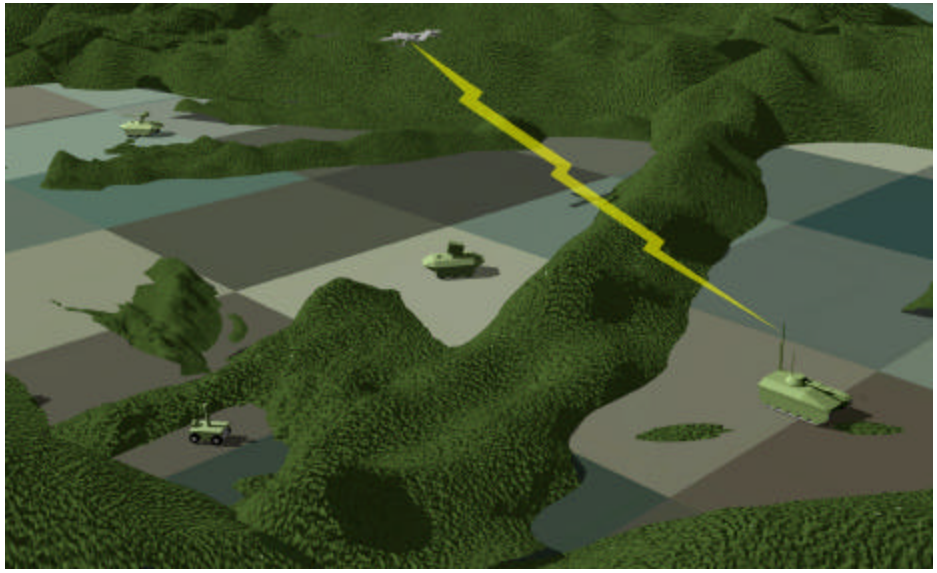
Army Ground Robotics for Future Combat Systems

Developing & demonstrating technology required to create multi-mission capable unmanned ground vehicles for a lighter, more lethal, highly survivable Objective Force

Path to Success

- **Rapidly develop, test and transition technologies critical for intelligent unmanned FCS components.**
- **Provide new options for light, deployable and survivable systems which are multi-mission capable with acceptable soldier workload.**
- **Attain performance levels consistent with FCS operational goals – Autonomous mobility at speeds of up to 40 MPH on FCS scale platforms – one soldier managing many unmanned systems**
- **Focus research to enable development of small, reliable, modular autonomous mobility technology packages for multi-mission, multi-platform application**



- **Develop technology for operational environments to accelerate transition to fielded systems**
- **Stress increased capabilities while maintaining current cost to provide affordability**

Early troop experimentation with advanced robotics technology critical for the Objective Force

Army Ground Robotics for Future Combat Systems

A clear strategy to provide robotics technology for FCS

- **Focused research:**
  - Machine perception
  - Intelligent control
  - Soldier-robot interface
- **Extensive testing**
  - Early continuous field tests
  - Troop interaction to focus research & foster parallel TTP development
- **Develop perception capabilities**
  - Sensor-rich now/down select later
- **Optimize use of a priori data:**
  - Digital terrain
  - UAV connection
  - Human-robot teams
- **Work with other agencies:**
  - Leverage other Government efforts (NASA, NIST, DOE, DARPA)
  - Industry
  - Academia
  - International

Autonomous Land Navigation for FCS and the entire Objective Force

Technology Maturity

Autonomous Land Navigation (Robotics)

Attributes	Objectives					
	FCS Best Estimated Need	Current	April 2003 Status	April 2003 Risk	April 2004 Status	April 2004 Risk
Performance						
Cross-country mobility (day)	40 MPH	10 MPH	30 MPH	M*	40 MPH*	M
Cross-country mobility (night)	25 MPH	5 MPH	20 MPH	M*	25 MPH*	M
Physical						
Mobility module size	10 ft^3	14 ft^3	10 ft^3	L	10 ft^3	L
Mobility module weight	180 lbs	180 lbs	180 lbs	L	180 lbs	L
Environmental						
Temperature Max/Min.	-50°,+125°F	+40°,+105°F	+40°,+105°F	L	+40°,+105°F	L
Programmatic						
Test Environment	Field Test	Limited Field	Field		Field	
Unit Cost (By calculation)		$370K/unit	$370K/unit		$370K/unit	
Overall TRL Level	NA	3-4	5		6	

*Demonstrated/Evaluated on larger platform, e.g., NAC 8X8 Hybrid Electric or new DARPA UGV.

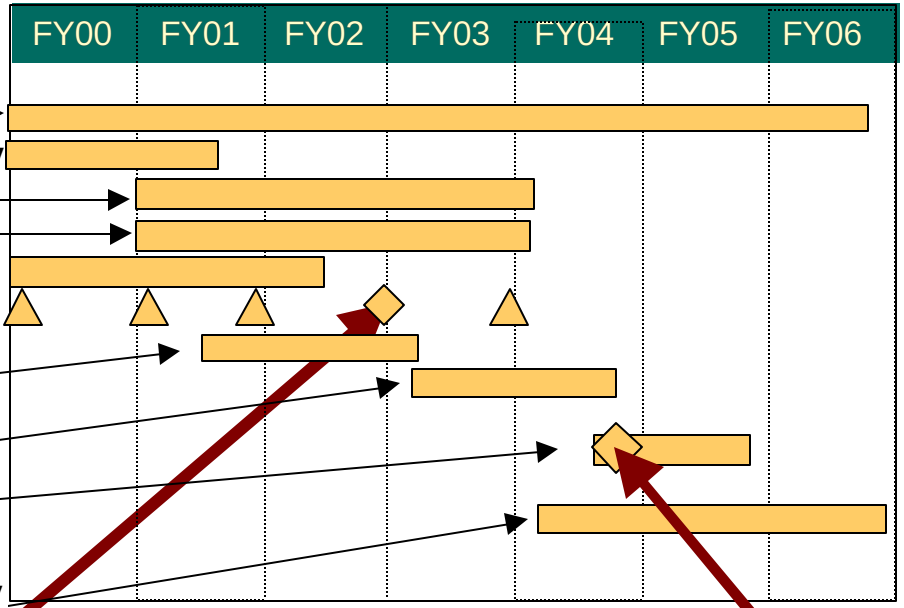
TRL Rationale

Subsystems → System

TRL	Description	Perception	Intelligent Control	Man-Machine Interface	Autonomous Mobility Technology
<u>Current</u> TRL 3-4	Development and testing through simulation & experiments followed by testbed Integration for experiments with troops	Obstacle detection/ classification with multiple sensor modes: stereo, ladar, & radar. testbed integration with troop experiments at Ft. Knox – 10/00	4D/RCS Architecture – Initial implementation on testbed vehicles for troop experiments APG - 9/99	Touch-screen based system developed & integrated for troop testing In virtual & live experiments 8/99 – 9/99	Development of component technology & integration onto testbeds for troop experiments – 10/00
<u>FY02</u> TRL 5	Extensive experiments including a user appraisal with XUV testbeds	G4 & Pyramid processors provide improved computer capability Development of improved AM sensors	Tactical behavior development – full 4D/RCS implementation	Control of 4 XUV's by single operator Exchange of control by operators	Maturation of component technologies, integration on 4 XUV's, with extensive testing & user appraisal
<u>FY04</u> TRL 6	Development of testbeds for in-scale tests of system concept	Multi-sensor fusion to provide terrain understanding & enable tactical behaviors in complex terrain	Management/ control of multiple heterogeneous robots by a single soldier	Embedding of MMI into FCS scale system	Integration on & rigorous experiments - FCS scale & heterogeneous systems,

Detailed Program Schedule

Autonomous Land Navigation (Robotics)



- Modeling & Simulation
- Obstacle Detect/Avoid Tech Dev
- Terrain/Object classification
- Tactical Behavior Development
- MMI Development
- Troop Experimentation
- Full-scale surrogate testbed design
- Testbed fabrication/technology integration
- System of systems experimentation
- Continued Robotics Technology Dev.

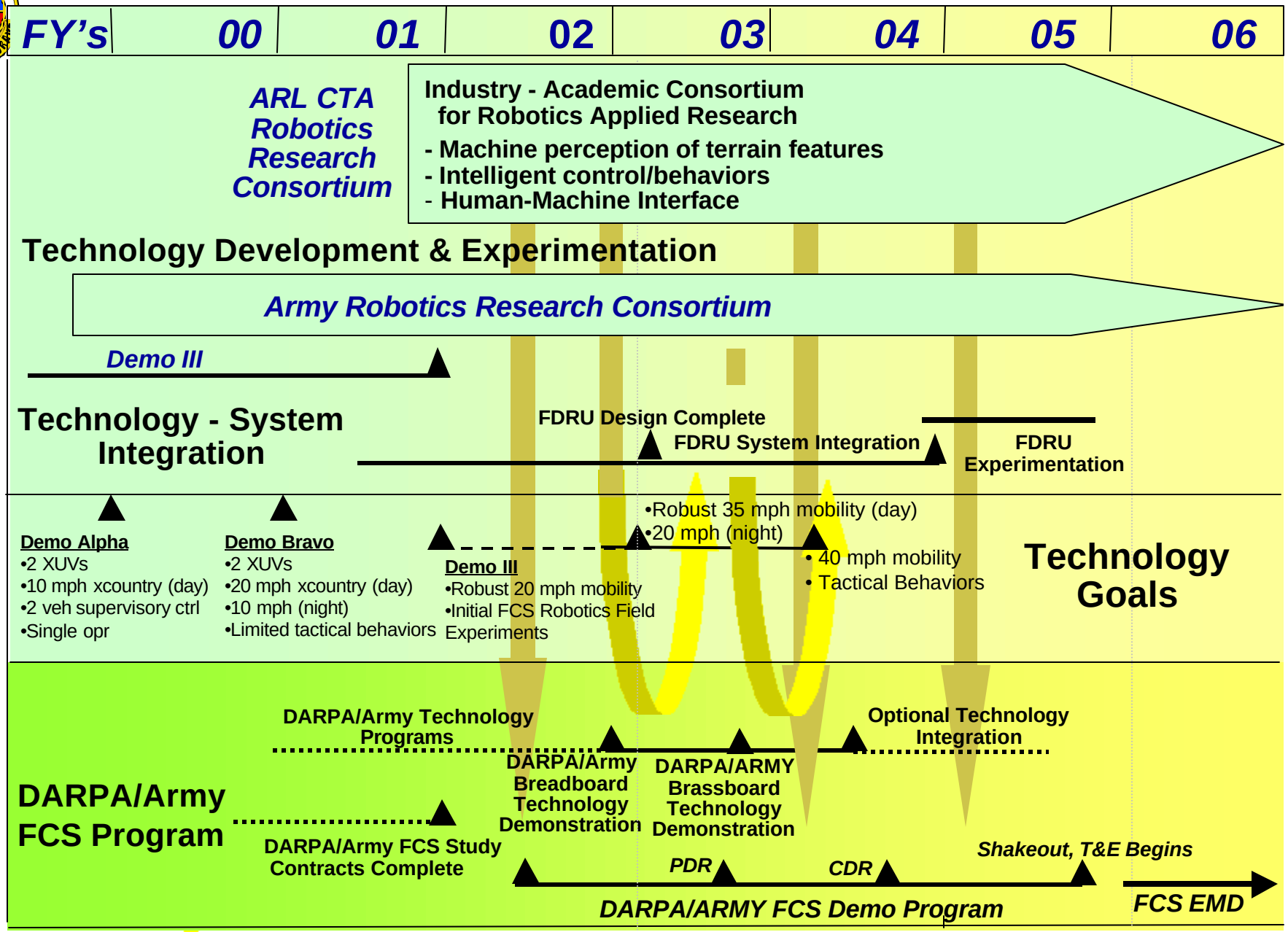
Breadboard Test -TRL 5

- Remote Sensor (XUV) testbed
- Rolling-wooded terrain - moderate difficulty
- Baseline terrain understanding/ tactical behavior set
- Cross-country mobility @ 65% of HMMWV

Brassboard Test -TRL 6

- Full-scale “FCS companion” surrogate testbed vehicle system
- Ft. Knox-like terrain
- Multi-mission behavior set
- Vehicle maneuverability @ 80% of manned tactical vehicle speed

Roadmap for Army Ground Robotics R&D



Army Ground Robotics Program Status

- **Demo III developing baseline autonomous mobility technology**
  - Demo IIIB features two vehicles maneuvering at speeds of up to 20 MPH
  - Demo III will feature one soldier managing up to four vehicles and tactical behaviors
- **Multi-organization partnership.**
  - ARL - Robotics Technology Development
  - TARDEC - System Integration, Demonstration, Experimentation
  - Other RDECs – Specific mission packages for future experimentation
- **Partnership with OSD**
  - Program received increased from OSD for development of autonomous mobility technology with near-term focus of completing Demo III objectives.
  - Responsibility for developing ground robotics technology for Joint Service application
- **Robotics Technology Alliance acquisition process initiated – initiation of alliance research program anticipated in Spring '01**

Summary

- **Aggressive robotics technology program**
- **Focused on enabling technology for FCS**
  - Multiple control modes
    - Autonomous (principal emphasis)
    - Semi-autonomous
  - Cross-country navigation at tactical speeds
- **Technology focal points are:**
  - Perception
  - Intelligent control
  - Soldier-robot interface
- **Extensive experimentation is underway**
  - Synchronized to FCS schedules
  - Provides performance data to guide FCS technology investment strategy